ROADWAY SYSTEM INTERCHANGE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority of U.S. Provisional Application No. 60/455,258 filed March 17, 2003, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] This invention relates generally to junctions and interchanges of roads and highways, and more specifically to roadway system interchanges which do not utilize traffic signals, stop signs, and other traffic control devices to restrict traffic flow.

[0003] Current interchange designs that provide full interchange capability for two intersecting highways are generally classified as one of diamonds, clover leafs, and stacks.

[0004] Diamond interchanges generally contain two traffic lights on the roadway which generally has less traffic volume and/or lower-speed traffic. The traffic lights restrict flow on, onto, and exiting from such a roadway. Single-point urban interchanges are considered an improved variation of the diamond interchange, by reducing the number of traffic lights from two to one. However, interchange methods which utilize traffic stoppage methods are unsuitable for traffic flow above a certain volume.

[0005] Clover leafs are a category of interchanges that are often suitable for moderate traffic volumes. Clover leafs are constructed frequently and familiar to most motorists. The primary advantage of clover leaf interchanges over diamond interchanges is that no traffic stoppage devices are utilized.

[0006] With the above described interchanges, there are eight direction change possibilities. The direction changes include turning from direction

'A' and the opposite direction 'B' of the first roadway, each onto both directions 'C' and 'D' of the second roadway. Likewise from direction 'C' and the opposite direction 'D' of the second roadway, each onto both directions 'A' and 'B' of the first roadway.

[0007] For clover leaf interchanges, four of the eight direction change possibilities require a turn of 270 degrees. These 270 degree clover leafs require a large land area within the interchange due to the large arc of the clover leaf. Such land area requirements typically result in a compromised solution of a small radius to reduce land usage, causing motorists to have to slow down because of the tighter radii of the clover leafs and further, wasting time and fuel to get back up to highway speed. Furthermore, the motorist traveling on a clover leaf is forced to merge with entering traffic as he exits one roadway, and merge with exiting traffic as he enters the other roadway. Because half of the traffic entering the first roadway from the second roadway enters the first roadway before half of the exiting traffic exits the first roadway, merges are inherently complicated due to the excess traffic volume. This causes traffic flow and safety problems when traffic volume exceeds a certain value.

[0008] Partial clover leaf interchanges are variants of the above described clover leaf interchanges which incorporate two 270 degree clover leafs. Partial clover leaf interchanges resolve some of the drawbacks of four 270 degree clover leafs, namely, that all of the traffic that is exiting the roadway exits prior to the traffic entering the roadway for a particular direction. However, partial clover leaf interchanges still retain some disadvantages of clover leaf interchanges, such as tight radius turns.

[0009] A popular modern class of high speed interchanges is commonly referred to in the industry as a "stack". Stack interchanges typically consist of three or four levels of overpasses on top of one another. Stack interchanges often allow large radius turns to be constructed, reducing the requirement for vehicle deceleration and acceleration. However, stack interchanges have a primary drawback in that they are extremely expensive due to the long lengths of elevated concrete

overpasses utilized. Maintenance and future interchange modification costs are also very high due to the long sections of concrete overpasses. Safety is compromised by increased icing problems of the long, highly elevated, concrete overpass sections during inclement weather. Emergency vehicle access in such condition is also difficult to provide. Some drivers are tentative while approaching and traversing the elevated overpasses, slowing traffic. In addition, many people consider stack interchanges unsightly, which often results in local resident opposition due to shadowing of their property and other considerations.

[0010] Other attempts have been made to address some of the shortcomings of the interchanges described above. One such interchange crosses the two traffic directions of each roadway, such that the continuing traffic prior to the interchange drives on the left side through the length of the interchange. Merging traffic from all left-turning directions merges from the left side of the roadway, which is not desirable from traffic flow and safety standpoints. Such a configuration is undesirable in part due to driver familiarity but more significantly to the established protocol of highest-speed through traffic being established in the left-most lanes.

BRIEF DESCRIPTION OF THE INVENTION

[0011] In one aspect, a roadway system interchange for a roadway system that includes at least one traffic lane approaching and passing through the interchange from each of four directions is provided. The interchange comprises a curved portion for each traffic lane passing through the interchange, at least one exit lane for each direction of traffic, a merging area for traffic wishing to change a direction of travel to a direction substantially similar to a left turn, and at least one second exit lane for each direction of traffic. The exit lane provides a substantial right turn for traffic wishing to change a direction of travel to a direction substantially similar to a right turn and the second exit lanes pass either under or over the traffic lanes in which travel is desired and changing in elevation to merge with the merging area.

[0012] In another aspect, a roadway system is provided which comprises a first road comprising one or more traffic lanes, a second road intersecting the first road, the second road comprising one or more traffic lanes, and an interchange configured to carry traffic through the intersection of the first road and the second road. The interchange further allows traffic to change a direction of travel at the intersection and comprises a curved portion for each traffic lane passing through interchange, at least one exit lane for each direction of the traffic lanes, a merging area for traffic wishing to change a direction of travel to a direction substantially similar to a left turn, and at least one second exit lane for each direction of the traffic lanes. The exit lanes provide a substantial right turn for traffic wishing to change a direction of travel to a direction substantially similar to a right turn, and the second exit lanes pass either under or over the traffic lanes in which travel is desired and change in elevation to merge with the merging area.

[0013] In still another aspect, a method for routing traffic through an intersection between a first road and a second road while also providing an ability to exit from one of the roads to either direction of the other road is provided. The roads have one or more traffic lanes in each direction. The method comprises curving a portion of each traffic lane passing through the interchange around a central area and providing at least one exit lane for each direction of the first and second roads, the exit lane providing a substantial right turn for traffic wishing to change a direction of travel to a direction substantially similar to a right turn. the method further comprises providing at least one second exit lane for each direction of the first and second roads, the second exit lanes passing either under or over the traffic lanes in which travel is desired and providing a substantial left turn for traffic wishing to change a direction of travel to a direction substantially similar to a left turn and providing a merging area for traffic on the second exit lanes, the merging area changing in elevation to merge with the traffic lanes to which the second exit lanes lead.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1 is a plan view of a roadway system interchange.

[0015] Figure 2 is a plan view illustrating interior details for the roadway system interchange of Figure 1.

[0016] Figure 3 is a plan view of an alternate roadway system interchange configuration which includes left-hand merges.

[0017] Figure 4 is a plan view illustrating alternate interior details for the roadway system interchange of Figure 1.

DETAILED DESCRIPTION OF THE INVENTION

[0018] Several embodiments for high-speed roadway system interchanges are described that improve traffic flow and safety, while decreasing construction and maintenance costs. The interchanges further include a center area bounded by the interchange which can be commercially developed to provide motorist conveniences such as fuel and food, or alternately used for farming or a variety of other purposes consistent with the amount and type of land bounded by the interchange. Turning radii for ramps are maximized as compared to known interchanges while minimizing land area that cannot be utilized. The large radius ramps provide an interchange that allows high vehicle speed from each roadway direction to the other roadway's two directions.

[0019] Overpass and elevated ramp distances are minimized for the embodiments described herein, allowing the interchange to function well with only two levels, greatly reducing cost of construction and maintenance. In addition, the described interchange embodiments which result in crossing roadways does not utilize traffic stoppage devices such as stoplights or stop signs. Also provided is an ability to have traffic entering a roadway to merge from the right side of that roadway for all of the merges, which is generally accepted as the preferred method from traffic flow and safety standpoints.

[0020] Figure 1 is a plan view of a roadway system interchange 10 which services two roadways 12 and 14. For the purposes of illustration, and by way of example only, roadway 12 is described as running North and South, and roadway

14 is described as running East and West. All directions are referenced as examples for clarity only, and are not intended to be limiting. In the example illustrated, roadways 12 and 14 each are four-lane highways, with two lanes in each direction of each highway. Specifically, northbound lanes 16 carry traffic through interchange 10, as do southbound lanes 18, eastbound lanes 20, and westbound lanes 22. While described in the context of a four lane highway, the structures described herein are adaptable to any combination of lane quantities, including multiple-lane exits if justified by traffic volume.

[0021] Northbound lanes 16, southbound lanes 18, eastbound lanes 20, and westbound lanes 22 each include a curved portion, passing through interchange 10. More particularly, northbound lanes 16 include a right curve portion 24, a center portion 26, and a left curve portion 28 which are utilized for passing through interchange 10. Similarly, southbound lanes 18 include a right curve portion 30, a center portion 32, and a left curve portion 34, eastbound lanes 20 include a right curve portion 36, a center portion 38, and a left curve portion 40, and westbound lanes 22 include a right curve portion 42, a center portion 44, and a left curve portion 46. In the embodiment illustrated, the curved portions of eastbound lanes 20 and westbound lanes 22 pass under the curved portion of northbound lanes 16 and southbound lanes 18.

[0022] Drivers have been notified of the upcoming exits and directions by any combination of road signs, painted notification in the lanes or other announcement methods. The traffic that wishes to turn north from westbound lanes 22 exits onto exit lane 50. This traffic then merges onto northbound lanes 16 shortly after left curved portion 28 at northbound merging area 52. Traffic that wishes to turn south from westbound lanes 22 continues past exit lane 50 and proceeds into the right curved portion 42 and then to center portion 44. From center portion 44, the traffic exits onto exit lane 54 from the left side of center portion 44. This left-turning traffic continues on exit lane 54 which passes under southbound lanes 18 near right turn portion 30. Exit lane 54 then raises in elevation and merges at southbound merging area 56 with center portion 32 of southbound lanes 18. As described above,

westbound traffic that wishes to continue westbound simply stays on westbound lanes 22, passing under northbound lanes 16 and southbound lanes 18 on right curve portion 42, center portion 44, and left curve portion 46.

[0023] Directional changes from directions other than from westbound lanes 22 operate similarly, except that traffic from northbound lanes 16 and southbound lanes 18 utilize an overpass, and traffic from eastbound lanes 20 utilize an underpass, the underpass and overpass configuration being for purposes of example only. Specifically, with respect to southbound lanes 18, an exit lane 60, a westbound merging area 62, an exit lane 64, and an eastbound merging area 66 are shown. With respect to eastbound lanes 20, an exit lane 70, a southbound merging area 72, an exit lane 74, and an northbound merging area 76 are shown. With respect to northbound lanes 16, an exit lane 80, an eastbound merging area 82, an exit lane 84, and a westbound merging area 86 are shown.

[0024] The turning radii along the roadway and through the above described components of interchange 10 are sized according to accepted highway construction standards, and are typically as large as the radii on other roadway sections as the roadway circumvents natural and manmade obstacles. Due to such turning radii, the traffic need not slow down for the turns within interchange 10 providing a feel of uninterrupted highway to the driver. Radii of exit lanes 50, 54, 60, 64, 70, 74, 80, and 84 in the preferred embodiment are also relatively large, allowing high-speed traffic.

[0025] Still referring to Figure 1, the right-turning exit lanes (i.e., exit lanes 50, 60, 70, and 80) are kept close at all points to roadway lanes. For example, exit lane 50 exits along right curving portion 42 of westbound lanes 22 and merges with northbound lanes 16 proximate left curving portions 28 of northbound lanes 16. Figure 1 illustrates that exiting from curved portions of traffic lanes reduces a typical arc for an exit ramp to be traveled from about 90° to a significantly lesser value, which provides a shorter ramp distance. A shorter ramp distance reduces construction costs, and a larger radius increases speed and improves traffic flow. Of

course, in a particular application, some combination of ramp distance and radius size is utilized.

[0026] In addition, because right curving portion 42 and center portion 44 pass under curved portions of northbound lanes 16 and southbound lanes 18 at an angle greater than 90° on an outside of interchange 10, right-turning exit lane 50, for example, is kept close to the roadways at all points, minimizing unusable space. The left-turning lanes are also kept very close at all points to the roadway lanes. For example, exit lane 54 exits along center portion 44, passes under center portion 32 of southbound lanes 18, then raises in elevation alongside center portion 32 and merges with southbound lanes 18 at southbound merging area 56. It can be seen that the non-perpendicular angles between the left turning lanes and the lanes the traffic is merging allow a larger radius, a shorter ramp distance, or combination of the two as compared to a standard interchange meeting at 90°. Therefore, the geometry of interchange 10 minimizes unusable space.

[0027] Unlike known interchanges, there is not a significant land area between the entry/exit lanes and the roadway lanes exited from and merged onto. However there is a significant land area 100 between the main traffic lanes (i.e., northbound lanes 16, southbound lanes 18, eastbound lanes 20, and westbound lanes 22). In some locations, land area 100 is bounded in part by entry and exit lanes attached or nearly attached to the roadway. Referring again to Figure 1, interior land areas 102, 104, 106, and 108 are bounded by exit ramps 54, 64, 74, and 84 respectively. Interior land areas 102, 104, 106, and 108 could be any combination of one or more areas to be used for development.

[0028] In one embodiment, interchange 10 is scaled, for example, to provide such areas which are each of sufficient size to provide a typical truck stop, fueling station with convenience market, large restaurant, motel, or similar motorist conveniences. These types of motorist conveniences are often developed at the exterior corners of major diamond interchanges, utilizing stoppage devices), but are

typically avoided at existing high-speed interchanges because known designs do not facilitate entry/exit to the developable locations from all traffic directions.

[0029] Exterior land areas 110, 112, 114, and 116 illustrated in Figure 1 are each bounded by three different traffic directions. In one embodiment, exterior land areas 110, 112, 114, and 116 are large enough and shaped well for such items as overnight truck parking or farming, but can also be developed for commercial or other purposes. In one specific embodiment, exterior land areas 110, 112, 114, and 116 are thirty acre plots. Of course, the sizes of interior land areas 102, 104, 106, and 108 and exterior land areas 110, 112, 114, and 116 can vary depending on development requirements and turning radii requirements.

[0030] An embodiment that illustrates a method of access and traffic flow to interior land areas 102, 104, 106, and 108 collectively referred to as service area 140 is shown in Figure 2. Westbound traffic that wishes to access interior land areas 102, 104, 106, and 108 (also referred to as convenience areas 142, 144, 146, and 148), in order to utilize the conveniences and services within service area 140 exit on exit ramp 54, then onto services entrance 150, passing under service exit 152, and proceeding onto to service roadway 154. The motorist can turn right into convenience area 142, or left into convenience area 148.

[0031] As illustrated, the motorist may also drive around an island 156 (commonly known as a "round-about") to get access to convenience areas 144 and 146, and alternately back to convenience area 148 if left turns across traffic are to be avoided within service area 140. When the motorist has decided to reenter a roadway, he selects the direction to travel. For example, if the motorist has stopped at convenience area 148 and wishes to go southbound, he will enter service area exit lane 160, passing over service entrance 150, merging onto exit ramp 54, under the southbound lanes 18, on to southbound merging area 56 and merging onto southbound lanes 18 as previously described. It is apparent that other directions are symmetrical including service entrances 162 for southbound traffic, 164 for eastbound traffic and 166 for northbound traffic. Similarly, service area 140 includes service exits 170, 172, and 174 as illustrated, service roadways 176, 178, and 180, and service area exit

lanes 182, 184, and 186. It should also be apparent that there are a large number of alternative embodiments for providing access to and exits from service areas similar to service area 140.

[0032] Figure 3 illustrates an alternative embodiment of an interchange 200. Interchange 200 has for left-turning traffic, a combination of left-exit / left-merge and right-exit / right-merge lanes. Specifically, the traffic that wishes to turn north from westbound lanes 22 exits onto exit lane 50, as described above. This traffic then merges onto northbound lanes 16 shortly after left curved portion 28 at northbound merging area 52. Drivers have been notified of the upcoming exits and directions by any combination of road signs, painted notification in the lanes or other announcement methods. Meanwhile, traffic that wishes to turn south from westbound lanes 22 continues past exit lane 50, proceeding onto center portion 44, and exits onto exit lane 202 from the right side of center portion 44. This south-turning traffic continues on exit lane 202 under southbound lanes 18, then raises in elevation passing over westbound lanes 22 and merges with southbound traffic onto southbound lanes 18 at southbound merging area 204. Westbound traffic that wishes to continue westbound simply stays on westbound lanes 22, passing under northbound lanes 16 and southbound lanes 18 as described above.

[0033] Still referring to Figure 3, northbound lanes 16 curve to the right in right curve portion 24 as northbound lanes 16 enter interchange 200. The traffic that wishes to turn right (East) exits onto exit lane 80 and merges with eastbound lanes 20 at eastbound merging area 82 as above described.

[0034] Meanwhile traffic that wishes to turn left (west) from northbound lanes 16 continues past exit lane 80, proceeding into center portion 26 of the curved area, and exiting onto left exit lane 206 from the left side of center portion 26. Left exit lane 206 lowers in elevation, in the embodiment illustrated, and merges at west merging lane 208 with westbound lanes 22 from the left side. Northbound traffic that wishes to continue northbound simply stays on northbound lanes 16, passing over eastbound lanes 20 and westbound lanes 22 as described above.

[0035] Traffic that wishes to turn north from eastbound lanes 20 continues past exit lane 70, proceeding onto center portion 38, and exits onto exit lane 212 from the right side of center portion 38. This north-turning traffic continues on exit lane 212 under northbound lanes 16, then raises in elevation passing over eastbound lanes 20 and merges with northbound traffic onto northbound lanes 16 at northbound merging area 214. Eastbound traffic that wishes to continue eastbound simply stays on eastbound lanes 20, passing under northbound lanes 16 and southbound lanes 18.

[0036] Southbound lanes 18 curve to the right in right curve portion 30 as southbound lanes 18 enter interchange 200. The traffic that wishes to turn right (West) exits onto exit lane 60 and merges with westbound lanes 22 at westbound merging area 62 as above described. Traffic that wishes to turn left (East) from southbound lanes 18 continues past exit lane 60, proceeding into center portion 32 of the curved area, and exiting onto left exit lane 216 from the left side of center portion 32. Left exit lane 216 lowers in elevation, in the embodiment illustrated, and merges at east merging lane 218 with eastbound lanes 20 from the left side. Southbound traffic that wishes to continue southbound simply stays on southbound lanes 18, passing over eastbound lanes 20 and westbound lanes 22 as described above.

[0037] The primary difference between interchange 10 (shown in Figure 1) and interchange 200 is that there are one or more left-hand merges. Access to interior land areas 102, 104, 106, and 108 is handled in a variety of manners similar to the embodiments shown. Specific to this embodiment, traffic stopping at interior land areas 102, 104, 106, and 108 from westbound lanes 22 can pass under center portion 26 on an access road (not shown). Traffic leaving interior land areas 102, 104, 106, and 108 and heading south can merge onto left curve portion 34 of southbound lanes 18 along an access road passing under center portion 38 of eastbound lanes 20. Traffic leaving interior land areas 102, 104, 106, and 108 and heading west can merge onto left exit lane 206, and merge onto center portion of westbound lanes 22. Northbound traffic incorporates similar features to those described for southbound traffic, and eastbound traffic incorporates similar features to those described for

westbound traffic. Turning radii and curvature features are largely similar between interchange 10 and interchange 200, facilitating high-speed traffic with minimal unusable land area.

[0038] Figure 4 illustrates an alternative embodiment for an interchange 250 that allows access to and exiting from convenience areas 142, 144, 146, and 148. For example, westbound traffic that wishes to access the conveniences exits on westbound exit ramp 252 then onto access loop 254 which substantially encircles convenience areas 142, 144, 146, and 148. To access convenience area 144, the motorist continues on access loop 254 and exits onto a convenience area entrance 256 and into convenience area 144. Similarly for the other convenience areas, convenience area entrances 258, 260, and 262 are also illustrated. Alternately, if there is enough merging distance, the initially westbound motorist could have exited directly from westbound exit ramp 252, onto access loop 254 and directly onto convenience area entrance 262, without a need to circle around all of the convenience areas. In alternative embodiments, additional lanes (not shown) within interchange 250 allow travel from one convenience area to another, providing traffic an alternative to traveling around access loop 254. To reenter the highway, traffic exiting area 142, for example, enters onto convenience area exit 270 and merges onto access loop 254 and circles around interchange 250 until the particular direction of traffic can be accessed. For example if the desired direction of travel from convenience area 142 is eastbound, the motorist will continue on access loop 254 and merge on eastbound merging area 66 then onto the eastbound lanes 20. Convenience area exits 272, 274, and 276 exit from convenience areas 144, 146, and 148 respectively.

[0039] For other desired directions from any of convenience areas 142, 144, 146, and 148, the motorists enter access loop 254 and travel around interchange 250 until they are able to access the desired one of merging areas 56, 66, 76, and 86. Southbound exit ramp 280, eastbound exit ramp 282, and northbound exit ramp 284 are also illustrated and operate in a similar fashion as does west bound exit ramp 252.

[0040] In the embodiments described herein, the roadways are described for right-hand driving, which is the standard for the United States and most other nations. It should be apparent that these embodiments are easily adaptable for left-hand driving situations with proper reversal of features. A multitude of variations and derivations from the described embodiments can be developed. For instance, distance of lane separation, location of points of inflection, methods of handling traffic in and around convenience areas 142, 144, 146, and 148, and other variables can be altered to fit particular installations or design requirements. Therefore, while the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.